	Systematic Error (Σ)			Random Error (σ)		
	Lateral (mm)	Longitudinal (mm)	Vertical (mm)	Lateral (mm)	Longitudinal (mm)	Vertical (mm)
Breast	1.67	1.30	1.57	1.87	1.43	1.85
Thorax	2.15	2.45	1.66	3.33	3.84	3.44
Prostate	2.30	1.32	2.00	2.71	1.78	2.73
Prostate operated	1.94	1.39	1.97	2.89	2.31	2.66
H&N	1.22	1.18	1.25	1.94	1.94	2.07
SNC	1.00	1.27	0.85	1.47	1.56	1.19
Pelvis	1.71	2.16	2.28	3.75	2.72	3.65
	PTV margins					
	Lateral (mm)		Longitudinal (mm)	Vertical (mm)		
Breast	5.47		4.25	5.22		
Thorax	7.70		8.82	6.56		
Prostate	7.66		4.54	6.90		
Prostate operated	6.87		5.10	6.79		
H&N	4.40		4.32	4.57		
SNC	3.52		4.28	2.95		
Pelvis	6.91		7.29	8.25		

The largest magnitude of Σ and σ for H&N was 1.94 mm, SNC was 1.56 mm, breast was 1.87 mm, thorax was 3.33 mm, pelvis was 3.75 mm and prostate was 2.89 mm. The PTV margins required are <4.5 mm for brain and H&N lesions, <5.5 mm for breast cancers, but range from 4.5 to 9 mm for thorax, prostate and pelvis lesions.
Theses values indicate the setup variations of each patient. The variations were smaller for the breast, SNC and H&N cohorts than the prostate, pelvis and thorax cohorts. The pelvis and breast cohorts showed the greatest variation in lateral direction and the prostate cohorts in vertical direction. The largest variation were presented in thorax cohorts in longitudinal direction and the lowest were in the SNC cohorts.

Conclusion: As the setup errors vary according to each immobilization systems, the analysis of each institution`s specific setup errors is essential for determining the PTV margins. The results were also used to define action level for online correction.

EP-1777

MRT investigation of prostate and lymph nodes movements: implications on planning target volume?

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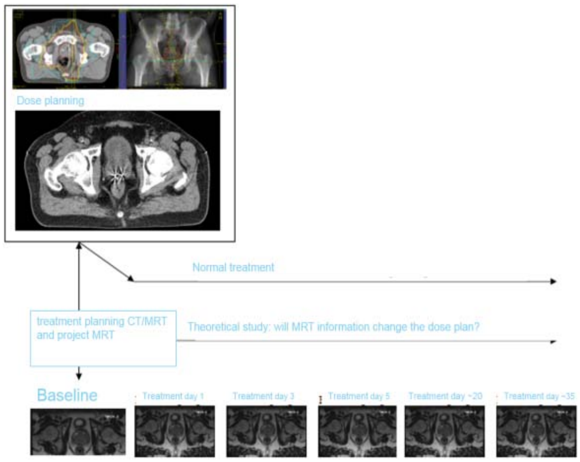
Purpose or Objective: The purpose of this project is to gather knowledge on the movement of pelvic lymph nodes relative to the prostate, seminal vesicles and bones in the pelvis and how this may affect the patient treatment plan.

Material and Methods: Until present, 10 patients have been included in the study. All patients have diagnosed prostate cancer and were treated with radiation therapy with curative intent. The patients followed the normal preparation and treatment procedure at our clinic - however, six additional MRI scans were acquired (baseline: before RT, on treatment day 1, 3, 5, 20 and 35) see figure. In each image set, several structures were delineated including fiducial markers, bony structures and lymph nodes. A radiologist identified lymph nodes along the common spread paths of prostate cancer. No suspected pathological nodes were found. Oncentra (Elekta) was used for image registration. Baseline images were defined as reference images and all other examinations were registered to the reference in two separate ways; bone matching and fiducial markers matching. For the bone matching, four structures were outlined; the disc between S1-S2, head of the right and left femur and the pubic symphysis. For the fiducial marker matching, the three gold markers in the prostate were outlined. In both cases the images were manually matched. Lymph node, seminal vesicle and prostate movements and morphological change were evaluated In MATLAB. Lymph nodes were grouped into regions: para-aortic (PA), common iliac (CI), pre-sacral (PS), internal iliac (II), obturator (Obt), and external iliac (EI) lymph nodes.



Results: We found that prostate moves up to 10 mm in anterior-posterior direction and up to 5 mm in right-left and cranio-caudal directions relative to bony anatomy from baseline scan. The lymph node group with the largest movements in right-left direction were CI with up to 20 mm difference from baseline. In the anterior-posterior and cranio-caudal directions, the maximum movement was 9 mm relative to bone from baseline scan. For the lymph nodes in the EI and PS regions, a significant difference was found depending on whether bone or fiducial markers were used for registration in right-left or cranio-caudal directions. In the other cases, no statistically significant difference between bone matching and fiducial marker matching was found

Conclusion: Preliminary findings suggest that the pelvic lymph nodes are more mobile than expected, indicating the need to account for that in treatment planning. However, more patients need to be included in the study before a conclusion can be drawn on the implications on the treatment plan.

EP-1778

On the feasibility of performing a 3D-scan with your own smartphone

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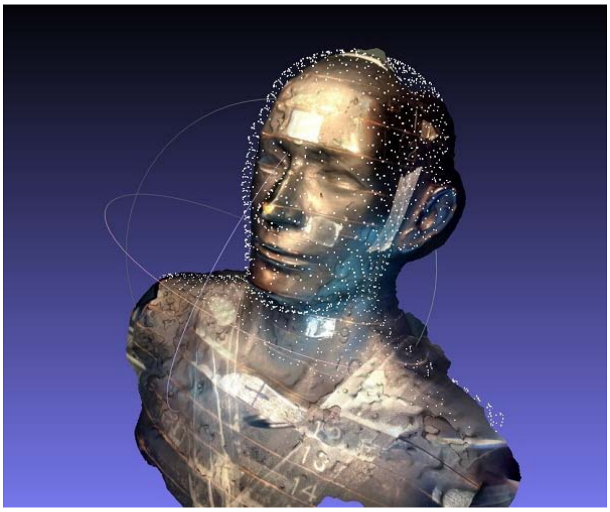
Purpose or Objective: Optical 3D Surface Scanner (3D-OSS) is a simple and easily reproducible method for patient alignment, and is an accurate tool to show anatomical changes, for example, in breast locations. The aim of this study was to evaluate the feasibility of both achieving within a few minutes an 3D-OSS using a smartphone and creating an image fusion between this 3D-OSS and the CT scanner, in a simple, cheap and reliable way.

Material and Methods: A smartphone and a free commercial app (TRNIO, www.trnio.com) were used to create an 3D-OSS. This app takes a series of pictures of your object as you move your smartphone around it. After a scan is completed, a 3D model will be generated on your phone. This 3D map is available for downloading on the TRNIO website. Although there are several image reconstructing algorithms available, in order to first show the feasibility of the method described here we will be using the commercial app. In the meantime, we are now ourselves developing an In-house software to do this. The RANDO Man Phantom (The Phantom Laboratories, Salem, New York) was used as a model. RANDO represents a 175cm tall and 73.5kg male figure. The phantom is constructed with a natural human skeleton which is cast inside soft tissue-simulating material. An image fusion was carried out between a RANDO OSS and a RANDO CT scan. A Body structure was created in our CT scan. In order to fusion it with the 3D-OSS we used MeshLab (a free processing system for 3D triangular meshes).

Results: Image fusion was successfully performed and the accuracy of it was measured both using predefined corresponding landmarks in the CT and visual confirmation. We performed this process for two locations on the phantom, Head & Neck and Body, and in both cases we got an accurate agreement.



Conclusion: This study was carried out using an existing commercial app in order to prove the feasibility of the method, using only a smartphone and free software. Therefore, we think it reasonable to believe that making your own 3D-OSS system could be done both in a simple and in a much cheaper way than the usually commercial alternatives available on the market.

EP-1779

Margins to compensate for deformity of the prostate/seminal vesicle in IGRT using fiducial-markers

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Purpose or Objective: In external beam radiotherapy for prostate cancer, image-guidance using fiducial-markers decrease set-up error and inter-fractional organ-motion error. However, daily deformity and/or rotation of the prostate/seminal vesicle could not be adequately detected by the verification of fiducial-marker position alone. The purpose of this study was to know how many margins should be added to compensate for the daily deformity and/or rotation of the prostate/seminal vesicle in the image-guided radiotherapy using fiducial-markers.

Material and Methods: Three-hundred ten fractions of nine patients with prostate cancer were examined. Patient setup was performed according to the position of two intra-prostate fiducial-markers (first-stage). Thereafter, with considering deformity and/or rotation of the prostate/seminal vesicle, the patient position was moved to the best position to achieve an alignment of contours of the prostate/seminal vesicle on daily cone-beam CT and contours of the clinical target volumes delineated on treatment planning CT (second-stage). Distance of movement in the second-stage was measured.

Results: An alignment in the second-stage was needed in 47 fractions of 310 fractions (15.2%). In 43 fractions (13.9%), movement of 1 mm was needed only in antero-posterior (AP) direction. Movement of 2 mm in AP direction, movement of 1 mm in cranio-caudal (CC) direction, and movement of 1 mm in AP and CC directions were needed in two fractions (0.6%), in one fraction (0.3%), and in one fraction (0.3%), respectively. No fraction needed an alignment in left-right direction.

Conclusion: With regard to image-guided external beam radiotherapy based on intra-prostate fiducial-marker position, margins of 1-2 mm in AP direction are necessary to compensate for the daily deformity and/or rotation of the prostate/seminal vesicle.

EP-1780

Dosimetric impact of isocenter accuracy in CBCT-guided SRS treatment of vestibular schwannomas

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Purpose or Objective: Linac radiation isocenter describes a path while gantry and couch are rotating during the treatment delivery of typical non-coplanar SRS plans. The aim of this study is to investigate the dosimetric impact of this isocenter "wobble" in SRS of a vestibular schwannoma (VS), and to validate the PTV margin used in our clinical practice.

Material and Methods: Five VS cases were enrolled in this study. The PTV was generated in the Eclipse TPS by expanding the CTV by an isotropic 2 mm margin, according to our SRS policy. A SRS non-coplanar plan ("reference plan") was designed in the Eclipse TPS by using static gantry IMRT technique. Eleven beams (6 MV) from a Varian Clinac equipped with a 120 Millennium MLC were used. Dose of 12.5 Gy (100%) was prescribed to cover 99 % of PTV.
On the other hand, fifteen CBCT-guided end-to-end (E2E) tests using a skull phantom were performed. E2E test permits to quantify the radiation isocenter misalignments in the X (lateral), Y (anterior-posterior) and Z (superior-inferior) directions.
For each VS case, eight X-Y-Z shifts generated from "mean ± 1.96 x SD" misalignments reported by E2E tests were simulated in the Eclipse TPS, resulting in eight "shifted plans". The following metrics were computed for each shifted plan and compared to the reference plan values: i) dose coverage of the CTV (D99%_CTV), ii) maximum dose to brainstem, iii) mean doses to cochlea, and iv) V10Gy, V5Gy and V2.5Gy of the brain (including the PTV).

Results: 1) Isocenter misalignments revealed by E2E tests were (mean ± SD): -0.4 ± 0.7 mm, -0.2 ± 0.5 mm and 0.2 ± 0.4 mm, in the X, Y and Z directions, respectively. Gaussian behavior was observed for each direction ($p > 0.05$; Shapiro-Wilk test). The probability of having shifts ≥ 2 mm is less than 1% in Lat, AP, and SI directions.
2) Target coverage was assured in the shifted plans; D99%_CTV: 103.1% ± 5.8% .
3) Shifted plans vs. reference ones revealed not statistically differences ($p > 0.05$; Two-tailed Student t-test) in brainstem maximum dose (7.1 ± 3.0 Gy vs. 7.2 ± 3.1 Gy) ; cochlear mean dose (5.3 ± 4.1 Gy vs. 5.1 ± 4.4 Gy) ; V10Gy brain (2.3 ± 1.5 cm3 vs. 2.3 ± 1.6 cm3); V5Gy brain (8.6 ± 5.1 cm3 vs. 8.6 ± 5.8 cm3); and V2.5Gy brain (43.4 ± 26.7 cm3 vs. 43.5 ± 30.1 cm3).

Conclusion:
1) The radiation isocenter "wobble" did not increase significantly the doses to brainstem, cochlea and brain.
2) Our study demonstrated that the 2 mm PTV margin used in our clinical practice was adequate for SRS treatment of VS.